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The university workers' willingness to pay for commuting

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Abstract. Using a dynamic approach, employing data on job mobility, we demonstrate that university workers' marginal willingness to pay for reducing commuting distance is about €0.25 per kilometre travelled. This corresponds to a marginal willingness to pay for reducing commuting time of about 75% of the net average hourly wage. For females, the willingness to pay is substantially higher than for males. It is also substantially higher for workers that work few hours per day, as predicted by theory.

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1. Introduction

There is a large literature which shows the importance of distance of students regarding educational choices, but the cost of commuting for university workers has been completely ignored. This is rather surprising because many high-quality universities in the world are located at expensive locations (e.g. in the centre of London). Presumably, these locations are attractive to students but for workers, who may be less willing to pay a premium to work at expensive locations; this usually implies that either housing or commuting costs are high compared to alternative jobs. In many (European) countries where wage scales are set at a national level, universities in expensive city centres have little possibility to compensate workers for high commutes which, at least theoretically, results in a misallocation of (potential university) workers over jobs.

In the current paper, we aim to estimate the university workers' time cost of commuting by using a dynamic methodology approach that use revealed preference data and derives this cost from the effects of commuting distance and wages on workers' quitting behaviour. We apply this approach to workers for whom the monetary costs of travel are largely reimbursed. Our methodology avoids the assumption of a competitive labour market, which is important in the context of universities, which have been shown to have monopsony power (Ransom, 1993, Barbezat, 2004). Given a competitive labour market, hedonic wage approaches are widely applied, but have been shown to induce biased estimates, in particular in environments where workers search for other jobs (Hwang et al., 1992; 1998).

Compared to previous studies that use a similar methodology (e.g. Manning, 2003a; 2003b; van Ommeren and Fosgerau, 2009), our application offers two methodological advantages. First, we focus on workers from one university who share the same workplace location, so many – difficult to observe – differences related to employer' industry and workplace location are controlled for (see, Zax, 1991; Villanueva, 2007; Gruetter and Lalive, 2009). Second, we use *administrative* data that contain detailed information about wages, so we largely avoid the measurement-in-wage problem, common in survey data, which biases the estimates (Van Ommeren and Hazans, 2008). In the context of commuting, it is important that our data are also informative about the presence of other transport-related fringe benefits (monetary travel subsidies, on-site parking permits) that determine largely the monetary cost of commuting, and precise information about jobs (the type of function, career opportunities). Furthermore, we have rather precise information about the hours worked per day (as well as number of days per week). This is relevant as theory predicts that workers with few daily work hours have a higher time cost of commuting (Manning, 2003a). To test this theory is not only relevant as it explains why (female) workers with few working hours commute less, it also helps us to understand the relationship between labour supply and commuting, a relationship which has received much attention in the theoretical literature (Parry and Bento, 2001; Arnott, 2007; Gutiérrez-i-Puigarnau and van Ommeren, 2010).

The structure of the paper is the following: Section 2 provides the theoretical methodology to derive workers' willingness to pay for commuting time. Section 3 contains the data description. The empirical analysis is presented in Section 4, while Section 5 offers concluding remarks.

2. Theory

In the current paper, we will use a dynamic search methodology approach to identify workers' willingness to pay for job attributes (e.g. commuting time), introduced in the seminal paper by Gronberg and Reed (1994). [1] It is essentially assumed that employed workers have to search for other jobs that are offered with a certain probability given an endogenously chosen search

[1] We follow Van Ommeren and Fosgerau (2009) who have extended this approach by relaxing some of the underlying assumptions. For empirical applications, see, among others, Manning (2003a, 2003b), Dale-Olsen (2006) and Isacsson and Swärdh (2007).

effort. Each worker has a job which provides a wage and job attributes and workers know the distribution of wages and job attributes of other jobs. Given an offer, workers have to accept or reject jobs.

The main idea of this approach is to use information about employees' *job quitting behaviour* (or job search behaviour). Given stationarity assumptions on the search environment, the employees' marginal willingness to pay for a job attribute is then obtained from the ratio of the marginal effect of the job attribute on the probability to quit and the marginal effect of the wage on the probability to quit (Van Ommeren and Fosgerau, 2009). More formally,

$$MWP_x \equiv \frac{\partial v / \partial x}{\partial v / \partial w} = \frac{\partial \Pr(\text{job quit})}{\partial x} / \frac{\partial \Pr(\text{job quit})}{\partial w}, \tag{1}$$

where MWP_x is the workers' marginal willingness to pay for attribute *x*, *v* is the workers' current utility of a job, which is a function of job attribute *x* and wage *w* ($\partial v/\partial w>0$), and Pr(job quit) denotes the probability that a worker *voluntarily* leaves the organization. This result is intuitive: employees attach a certain (dis)utility to job attributes as well as to wages, which is revealed through the likelihood that employees quit if workers are confronted with a marginal change in *w* and *x*. We will now focus on one job attribute: commuting time.

To estimate (1), one has to put some restrictions on the functional form of Pr(job quit). If it is assumed that $\Pr(\text{job quit}) = f(\beta_x \log x + \beta_w \log w)$, where β_x and $\beta_w < 0$ are parameters to be estimated, *logx* is the logarithm of commuting time *x*, *logw* is the logarithm of *w*, and *f* is an arbitrary continuous function (increasing in its argument), then:

$$MWP_x = \frac{\beta_x}{\beta_w}\frac{w}{x}. \tag{2}$$

Hence, to derive MWP_x and therefore the workers' cost of commuting, it is sufficient to obtain estimates of β_x and β_w.

The above specification of f ignores interaction effects between commuting time and other variables. According to theory, the length of the working day is important, because the MWP_x is proportional to the inverse of the daily hours of work, denoted by h (see, Manning, 2003a). This is intuitive as workers with few working hours per day apparently have high opportunity costs of working. To capture this, we include also the ratio of log distance and daily hours in f, so $\Pr(\text{job quit}) = f(\beta_x \log x + \beta_{xh} \log x / h + \beta_w \log w)$, where $\beta_w < 0$ and $\beta_x + \beta_w / h < 0$. The MWP_x must be changed accordingly and now it reads as follows:

$$MWP_x = \frac{\beta_x}{\beta_w}\frac{w}{x} + \frac{\beta_{xh}}{\beta_w}\frac{w}{xh}. \tag{3}$$

So, to estimate MWP_x, one must estimate β_x, β_w and β_{xh}.

3. Data Description

We focus on employees of the VU University in Amsterdam, which is (accidentally) located at the most expensive location in the Netherlands.[2] All employees work at the same workplace location. One of the main characteristics of this location, relevant to the current application, is that it is at walking distance from a train station, at cycling distance from the city centre and many suburbs of Amsterdam and only a couple of minutes drive from a major, although heavily congested, highway. We use detailed administrative data for employees who are younger than the compulsory retirement age (65 years), to limit the impact of involuntary transitions into retirement, and who are on a permanent contract. As the involuntary quit rate of personnel on permanent contracts is negligible, we may safely assume that all quits are voluntary, as required by the theoretical framework detailed in Section 2. The data refer to the

[2] We believe the choice of an expensive location has been accidental. When the VU university was established as this location was not expensive.

month February in the years 2003 until 2010, which allows us to calculate annual quit rates.[3] In total, we have 19,554 observations about quitting behaviour from 5,303 employees.[4]

We have information on a range of workers' characteristics: age, commuting distance, gender and hourly gross wage. Most studies focus on wages to derive the workers' marginal willingness to pay but one may also use other *monetary* job attributes. In our application, employees who travel by public transport receive a reimbursement of about 50% to 70% of the travel cost, whereas other employees, if the commuting distance exceeds 10 km, receive a reimbursement of € 0.04 per one-way km per day, up to a maximum of € 65 per month. One might consider to use a reimbursement is an additional factor in the quit decision. However, since the reimbursement is small relative to the salary, about 4% of the gross wage, we have included it in the gross wage. Distinguishing between these monetary components does not change the results.

Furthermore, we use weekly hours, number of days worked per week as control variables.[5] We also use information on daily hours worked which we use to interact with commuting distance. We derive average daily hours by dividing weekly hours by number of workdays. This creates some measurement error, because for some workers daily hours vary per day of the week (e.g. they work 4 days 8 hours and one day 4 hours). For the last two waves of the sample, we have detailed information on the exact number of hours worked per day of the week. It appears that only 8% of workers vary daily hours over the week. Thus, the average number of daily hours is a rather accurate measure. [6]

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[3] The 2010 wave is merely used to determine quits. So, the dummy variable $quit_{it}$ is 1 when worker i is observed in wave t but not in wave $t+1$.
[4] We exclude few observations with a commute longer than 150 km, a commuting reimbursement above 20% of the salary, daily working hours less than 1.5 or in excess of 10 or a hourly wage above €100.
[5] Using daily hours rather than weekly hours or number of days worked per week generates identical results to the results presented here.
[6] We also lack information about the start time (see Gutiérrez-i-Puigarnau and van Ommeren, 2012). However, as a rule, most workers and in particular faculty members are quite flexible regarding time.

Administrative data usually do not contain information about workers' educational level. Fortunately, the university's personnel files contain information about the workers' academic title. We were thus able to infer educational level, distinguishing between workers without university degree, with a Master degree or a PhD.[7]

We know workers' job title, which allows us to distinguish between *faculty members, academic support staff* (teaching and research support functions, including student relations) and *administrative staff*.[8] We have also incomplete information about (the use and eligibility of) parking permits, which we use as a control variable. Parking permits are provided to eligible employees (at a cost of less than € 1 per day), but as only 30% of the employees who are eligible apply for it, the policy is not restrictive for most workers and few workers travel by car who don't receive a parking permit.[9] We also control for the use of public transport.[10] These data indicate that at least half of workers commute by bicycle.

We also control for recent *promotions*. This is relevant in a search context but usually difficult to control for. We are able to do so, because the wage policy of the university is based on 10 broad wage scales; wage scales are further subdivided into maximally 12 steps. Advancement *within* a scale is, almost always, automatic: one step per year. Advancement *between* scales, however, is not automatic: passage onto the next wage scale is conditional on a successful job evaluation. Hence, each progression in scale implies a promotion.[11]

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[7] We also know if the field of study was technical (i.e., engineering) or law, but distinction by field appeared not to be relevant for the results presented.

[8] Faculty members, academic support and administrative staff represent respectively 26, 17, and 57% of the workforce on a permanent contract.

[9] Eligibility depends on the ratio of car and public transport travel times. In addition, some parking permits are allocated by faculties. Unfortunately we were not able to recover complete information on permits allocated by faculties as information for the first years of our sample was particularly poor.

[10] Information about public transport is derived from annual commuting reimbursements that depend on the mode of transport. Probably this understates public transport use by several percentage points. Company cars are important fringe benefits in the Netherlands (Gutiérrez-i-Puigarnau and van Ommeren, 2011), but not provided by public organisations such as universities.

[11] The dummy variable $promotion_{it}$ is 1 when workers i is observed in wage scale H in t-1 and in wage scale H+1 (or higher) at time t.

In addition, we aim to control for the *lack of promotion opportunities*. Normal career progression entails that workers move to the next scale when they are between the 5th and 7th step. Hence, most workers that are relatively high up in the step level are either less productive than it may have been expected a priori or have attained a scale level such that promotions are difficult to realise within the university. In particular, workers at the very top of the scale are likely to have been passed on for promotion many times in a row, and it is thus very unlikely that they will be promoted in the future. Since the lack of promotion possibilities will affect the workers' expectation of wage increases with the current employer, we have included a dummy variable signalling when a worker is at the top of the scale (e.g. step 10 to 12).

The average one-way commuting distance of workers is 22 km, so the daily commuting distance travelled is 44 km.[12] The average full-time equivalent gross yearly wage is €47,665, above the average gross salary of Dutch workers (about €32,000). The average gross hourly wage is €26.5, which amounts to an average gross daily wage of €212. Most workers face a marginal income tax rate of about 50%, consequently net average daily wage is about €106 and the net hourly wage is just above €13. Summary statistics of other variables used in the analysis are provided in the appendix.

4. Empirical Analysis

To estimate the workers' marginal willingness to pay for commuting time, we have estimated the workers' probability to quit, using a worker random effects logit model (Model 1). The results are presented in Table 1 in columns 1 (coefficients) and 2 (marginal effects). It appears that the distance to daily hours variable has a positive effect (0.844 with a standard error of 0.444), although it is imprecisely estimated. The effect of distance itself is highly insignificant

[12] In the Netherlands, the average one-way commuting distance is about 17 km, it raises to 21 km among workers with university degrees.

(t-value is 0.15). Because a standard likelihood ratio test shows that *both distance variables* are jointly *highly* significant ($\chi^2(2)$ = 12.42), we present the results of a model that only includes the distance to daily hours variable (Model 2). This is equivalent to setting β_x=0 so that the entire first term in equation 3 equals zero. The difference in the log likelihood of both models is trivial and in terms of interpretation the results are identical.

We find a negative effect of wage, β_w = -1.216 (s.e. 0.169), whereas the effect of the ratio of commuting distance to daily hours, β_{xh}, is positive (0.889 with a standard error of 0.219).[13] This implies that the workers' willingness to pay to avoid a longer commute is decreasing in daily working hours, in line with Manning (2003a). The specification implies that the MWP_x for a full-time worker who works 8 hours a day is half the MWP_x for a part-time worker who works only 4 hours a day.

Equation (3) implies, evaluated at the mean, that the average MWP_x to reduce the commute by one kilometre is €0.490 (s.e. 0.130), so €0.245 (s.e. 0.065) per kilometre travelled.[14] Given an average commuting speed of 40 km/h, this corresponds to an average willingness to pay of about €9.80 to avoid one hour of commuting (with a standard error of 2.59), about 75% of the average net hourly wage.

It is plausible that this estimate predominantly refers to time losses. Usually, it is thought that monetary costs and the monetary value of the time losses are of the same magnitude (van Ommeren and Fosgerau, 2009). However, workers who travel by public transport receive an imbursement between 50 to 70% of the expenses, so for these workers the costs predominantly refer to time losses. Also other workers received a monetary compensation (up to € 60 per month), as parking costs are quite small (less than € 1 per day).

[13] We have also estimated models including a quadratic term in log wage. Although the latter term appears significant, within the relevant wage range, the effect on the probability to quit is negative.
[14] Standard errors are calculated using the delta method. The average daily net wage is €106, daily work hours is 7.27, and one-way commuting distance is 22 km.

Table1: Random effects logit estimates of the probability to quit

	Model 1		Model 2	
Dependent variable: quit	Coefficients	Marginal Effects	Coefficients	Marginal Effects
log wage	-1.216*	-0.105*	-1.216*	-0.105*
	(0.169)	(0.015)	(0.169)	(0.015)
log distance	0.010	0.001		
	(0.074)	(0.006)		
log distance/daily hours	0.844	0.073	0.898*	0.078*
	(0.444)	(0.038)	(0.219)	(0.019)
no promotion opportunities	0.154*	0.013*	0.154*	0.013*
	(0.076)	(0.007)	(0.076)	(0.007)
recent promotion	-0.682*	-0.059*	-0.682*	-0.059*
	(0.108)	(0.009)	(0.108)	(0.009)
public transport	-0.427*	-0.037*	-0.425*	-0.037*
	(0.085)	(0.007)	(0.082)	(0.007)
parking permit	-0.107	-0.009	-0.105	-0.009
	(0.156)	(0.013)	(0.155)	(0.013)
Work hours				
Hours worked per week / 38	1.098*	0.095*	1.140*	0.099*
	(0.498)	(0.043)	(0.397)	(0.034)
1 day per week	1.939*	0.168*	1.968*	0.170*
	(0.394)	(0.034)	(0.332)	(0.029)
2 days per week	1.452*	0.126*	1.475*	0.128*
	(0.317)	(0.027)	(0.268)	(0.023)
3 days per week	0.912*	0.079*	0.928*	0.080*
	(0.220)	(0.019)	(0.186)	(0.016)
4 days per week	0.302*	0.026*	0.310*	0.027*
	(0.123)	(0.011)	(0.108)	(0.009)
Education				
master degree	-0.514*	-0.045*	-0.514*	-0.044*
	(0.102)	(0.009)	(0.101)	(0.009)
no university degree	-0.857*	-0.074*	-0.856*	-0.074*
	(0.127)	(0.011)	(0.127)	(0.011)
Type of job				
faculty	-1.340*	-0.116*	-1.339*	-0.116*
	(0.115)	(0.010)	(0.115)	(0.010)
administrative	-0.718*	-0.062*	-0.719*	-0.062*
	(0.097)	(0.008)	(0.097)	(0.008)
Number of observations	19,554		19,554	
Number of individuals	5,303		5,303	
Rho	0.301*		0.301*	
	(0.031)		(0.031)	
Log likelihood	-6273.493		-6273.502	

Note: Standard errors in parentheses, *: significant at 5%. The model also contains controls for year (7 dummies), civil status (4 dummies), gender, age, age squared and a dummy for two jobs at the university. Reference groups of the variables in parentheses: number of working days (5), education (PhD), type of career (teaching support).

Furthermore, our sample contains a rather high (but for the Netherlands quite common) proportion of bicycle users for whom marginal monetary costs of travel are negligible.[15]

We have tested this result using many alternative specifications. For example, we have tested if the disutility of commuting and the utility of wages vary among workers using a random coefficient specification (that is we let the coefficient of the wage and of the commuting distance to vary among workers). We found that the implied distribution of the coefficients is degenerate (has a variance very close to zero). We have also estimated models with other interactions and controls (e.g. weekly hours rather than daily hours; the logarithm of daily hours rather than daily hours), but this result remains robust.

The MWP_x differs strongly between full-time and part-time workers, because of differences in the hours worked *per day*. For full-time workers, MWP_x is 0.222 (with a s.e. of 0.059). The MWP_x for workers on part-time jobs with 20 week hours per contract is almost twice as high: 0.396 (with a s.e. of 0.105). We have also estimated the model interacting both wage and the distance to the daily hours variable with part-time status. Both the interaction terms are far from statistically significant (with t-values of 0.25 and 0.70 respectively). Consequently, we are not able to detect any additional difference in the MWP_x between part-time and full-time workers when accounting for the difference in the daily number of working hours.

We have also estimated models allowing for different impacts of wages and distance for faculty and non-faculty staff. We find that the effect of distance is somewhat higher for non-faculty workers.[16] For non-faculty workers, MWP_x equals 0.292 (s.e. 0.081), about 20%

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[15] The coefficient on distance remains positive and significant also when wage is not included in the quit regression, which implies that workers are *not* fully compensated for their commuting losses (Manning, 2003a; Stutzer and Frey, 2008).

[16] This finding also holds if we interact distance with educational level. The effect of wage is statistically insignificant for faculty workers, which prevents us from interpreting the MWP_x for faculty workers, but the results suggest that their MWP_x is (much) lower.

higher than the population-average MWP_x reported above. The effect of wage is statistically insignificant for faculty workers, which prevents us from interpreting the MWP_x for faculty workers, but the results suggest that their MWP_x is (much) lower.[17]

Men and women usually experience different patterns of labour market transitions, so we have paid special attention to gender. We have re-estimated the models interacting wage and distance with gender. Using an average daily wage (distance) of €99 (38.74km) for women and of €116 (45.64km) for men, we obtain a MWP_x of 0.122 (s.e. 0.073) for men and of 0.675 (s.e. 0.183) for women. The difference in the MWP_x across the gender dimension is substantial, 0.553 (s.e. 0.193), and statistically significant. These results indicate that, consistent with Van Ommeren and Fosgerau (2009), and a large labour market literature which shows that women react stronger to changes in the labour market than men, women have a higher MWP_x to pay than men.

Control variables have the expected effects on the probability to quit. For example, career concerns are an important determinant of quitting decisions: recently promoted workers are less likely to quit and workers who have no promotion opportunities are more likely to quit. In addition, workers with a PhD are more likely to quit. We also find that the likelihood of quitting decreases almost linearly with the number of days worked. The probability to quit increases with the length of the working week, but the effect is only significant at 10% confidence level. Workers with two jobs at this organization are characterized by a lower likelihood of quitting. The effect of having a parking permit is not strong enough to be properly identified with our data. Workers commuting by public transport tend to quit less. This result makes sense when it is recognised that given short distances Dutch workers tend to use the bicycle whereas workers with long commutes who do not use public transport usually

[17] This makes sense, because faculty members are not only higher educated than the average worker, they have also more specialized jobs and have more flexibility with regard to teleworking as well as work start hours, which is relevant to avoid peak congestion. Thus their characteristics mirror long-run trends towards increasing education, specialization and flexibility, which one observes nowadays.

live at residence locations where the supply of public transport is poor, so they have to rely on the car, but as the highways close to the university are highly congested, these workers face an unusual inconvenient commute.

5. Conclusion

The current paper estimates the university workers' willingness to pay for commuting using data from the personnel files of a Dutch university, by means of a dynamic job search approach based on job quitting behaviour. So, we identify the willingness to pay using revealed preferences data, whereas the majority of studies rely on stated preferences (e.g. De Borger and Fosgerau, 2008). The approach does not rely on the restrictive assumption of a static fully-competitive labour market, see Hwang et al. (1998), which has been shown not to apply to university workers.

Our preferred estimate, robust to alternative model specifications, implies that the university workers' willingness to pay to avoid a one kilometre increase in the commute is €0.245. Given assumptions on speed, and noting that these workers hardly pay for monetary costs of travel, this suggests a cost of commuting time of about 75% of the workers' average (net) hourly wage. The cost is strongly decreasing in the number of *daily* hours worked in line with theory, and is higher for female and non-faculty workers.

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Appendix 1: Summary statistics

	Mean	Standard Deviation
quits	0.124	0.330
annual wage (thousand Euro)	47.652	18.349
log wage	3.796	0.362
commuting distance (km)	22.073	23.032
log commuting distance	2.684	0.970
no promotion opportunities	0.704	0.456
recent promotion	0.109	0.312
public transport	0.255	0.436
parking permit	0.053	0.224
Job characteristics		
two jobs (at the organization)	0.021	0.144
number of weekly hours / 38	0.829	0.234
number of daily hours	7.269	0.901
Number of working days		
1	0.035	0.184
2	0.044	0.206
3	0.107	0.310
4	0.213	0.410
5	0.601	0.490
Personal characteristics		
men	0.603	0.489
age	45.493	10.260
age squared (/100)	21.748	9.240
Civil status		
married	0.514	0.500
living together	0.141	0.348
single	0.280	0.449
widow (er)	0.008	0.089
divorced	0.056	0.229
Education		
PhD	0.328	0.470
master degree	0.246	0.431
no university degree	0.426	0.495
Job type		
teaching support	0.166	0.373
faculty	0.262	0.439
administrative	0.572	0.495
Number of observations	19,554	
Number of individuals	5,303	